Perils of "industrial gene" and "beanbag genetics"

Sir,

Wilkins[1] pointed out that the outcomes of the alluring promises of biotechnology need reassessment. He suggests that ignorance, hubris and institutional and strategic inertia are factors responsible for the lack of fulfillment of these promises. I think an additional factor was that biotechnology proponents did not appreciate, in their hubris or otherwise, the amount of knowledge that geneticists and evolutionists had even in the 1970s.

The "new biologists" of the post-DNA era, trained in a "reductionist" approach, examined individual components in isolation instead of addressing biological complexities in a wider perspective. Reductionism provided clearer "cause and effect" relationship and therefore, "one issue at a time" or "one gene–one phenotype" concept had global appeal. Although molecular details of gene regulation were largely unknown till recently, geneticists and evolutionary biologists had long appreciated the complexity of gene–phenotype relationship and gene interactions. Way back in 1934, Muller and Prokofjeva[2] stated that the genetic material forms an "organic system" in which the composition and interrelation of the "units" are important. Without knowing the "part" and "sub-parts" of the "units", they were at least conscious of interaction between genes. Mayr[3] explicitly stated in 1970 the importance of regulatory genes while observing that the conservation of structural genes "from bacteria to the highest organisms, can be much better understood if we ascribe to the regulatory genes a major role in evolution. . .. The rate of evolutionary change in the macromolecules of important structural genes is presumably largely controlled by the system of regulatory genes." Mayr, worried about the consequences of considering only the structural or protein-coding genes of significance, further observed "day will come when much of population genetics will have to be rewritten in terms of interaction between regulator and structural genes. This will be one more nail in the coffin of beanbag genetics." He emphasized that the genotype of the individual is a whole and the genes of a gene pool form a unit. Yet, the protein-centric "central dogma" continued with large chunks of genomes denigrated as "junk" or "selfish". This further promoted the simplistic belief that engineering of one gene may produce the "desired" advantage. Proponents of biotechnology in the 1970s ignored the importance of networks and interactions in biological organizations and ironically even today, many believe in "beanbag" genetics and look for "industrial gene".

Intense research driven by biotechnology has of course remarkably improved our understanding of basic life processes. Yet, we still do not know the full protein-coding component of our genome, let alone the near complete ignorance of the bulk of the "non-coding" component, much of which is obviously involved in regulatory networks[4] as Mayr[4] suggested. Therefore, to think of manipulating any genome to our advantage, with the little knowledge that we have even today, is premature and frightening.

The "biotechnology" revolution has also affected education. Teaching programmes in biotechnology were started in India in the mid 1980s so that an adequately trained human resource could maximally exploit its benefits. The unrestrained rush to learn/teach biotechnology diverted both the younger minds and resources to the newly established departments of biotechnology in various institutions across the country at the expense of existing traditional departments. Given the enormous population pressure and scant job opportunities, the young generation and their parents believe that, like information technology, biotechnology will provide a highly remunerative career. In this mad rush, young students learn neither biology nor technology since the laboratories as well as the teachers are ill-equipped. Since the biotechnology industry did not grow as expected, most of the biotechnology graduates come back to traditional departments to do their PhD, although they did not want to take their earlier degrees in this field! In this uncertain and fluid state, the old and established departments of conventional biological disciplines have dwindled because of lack of adequate financial support and good human resource (bright students and a capable faculty). Therefore, I suggest that teaching of Biotechnology or Bioinformatics as independent subjects at school and undergraduate levels needs to be stopped and even the MSc programmes require to be made more integrative. At the same time, the life-science-related teaching departments need to be revived to provide holistic education that stimulates deeper questions rather than just teach so-called "modern" techniques in the unfounded hope of material gains.

References

1. Wilkins AS. 2007. For the biotechnology industry, the penny drops (at last): genes are not autonomous agents but function within networks! Bioessays 29:1179–1181.
2. Muller HJ, Prokofjeva A. 1934. Continuity and discontinuity of the hereditary material. Dokl Acad Nauk SSSR NS 4:74–83.
3. Mayr E. 1970. Populations, Species, and Evolution. An abridgment of Animal Species and Evolution. Cambridge (USA): Harvard University Press. 183 p.
4. Malik M, Lakhotia SC. 2007. Noncoding DNA is not "junk" but a necessity for origin and evolution of biological complexity. Proc Natl Acad Sci India. 77(B) Spl issue:43–50.

Subhash C. Lakhotia

Cytogenetics Laboratory, Department of Zoology
Banaras Hindu University, Varanasi 221 005, India
E-mail: lakhotia@bhu.ac.in

DOI 10.1002/bies.20727
Published online in Wiley InterScience (www.interscience.wiley.com).